ORIGINAL ARTICLES

Aging and cortical bone density of mandible with CBCT

Ichiro Ogura*[1], Yoshihiko Sasaki[2], Mikiko Sue[2], Takaaki Oda[2], Ayako Kameta[1], Kazuhide Hayama[1]

[1] *Department of Oral and Maxillofacial Radiology, The Nippon Dental University School of Life Dentistry at Niigata, Niigata, Japan*

[2] *Radiology, The Nippon Dental University Niigata Hospital, Niigata, Japan*

Received: October 26, 2018 **Accepted:** November 30, 2018 **Online Published:** December 4, 2018

DOI: 10.5430/ijdi.v5n2p23 **URL:** https://doi.org/10.5430/ijdi.v5n2p23

ABSTRACT

Purpose: To clarify the relationship between aging and cortical bone density of mandible with Cone-beam CT (CBCT).

Materials and methods: We reviewed the CBCT imaging of 202 patients who were examined in mandibular region by CBCT. The patients were classified into 2 categories: young group ($\leq$ 50 years; 51 male and 73 female) and elderly group (> 50 years; 22 male and 56 female). The relationship between aging and mandibular cortical bone radiographic density as gray values with CBCT was analyzed using Pearson's rank correlation test. Regarding age groups, mandibular cortical bone radiographic density using CBCT was analyzed with ANOVA with Tukey's HSD test.

Results: Cortical bone radiographic density in female using CBCT was significantly correlated to age ($Y = -6.741X + 1,946, R^2 = 0.351, p = .000$). Furthermore, the cortical bone radiographic density in young female ($1,754 \pm 144$) was significantly higher than that in young male ($1,554 \pm 164, p = .000$), elderly male ($1,533 \pm 115, p = .000$) and elderly female ($1,484 \pm 228, p = .000$).

Conclusions: We confirmed the changes of cortical bone of mandible with age in female using CBCT. Furthermore, the evaluation of mandibular cortical bone using CBCT should be useful for predict factor of decreased bone mineral density.

Key Words: Aging, Mandibular cortical bone, Bone density, Osteoporosis, Cone-beam CT

1. INTRODUCTION

Bone mass loss and high risk of pathological fractures are the major symptoms of osteoporosis.[1] The medical community need the developing accurate early diagnostic methods, because no signs of the osteoporosis are clear until a pathological fracture happens.[2] Characteristic of osteoporosis reduced the bone strength that mirrors the integration of both bone mineral density (BMD).[3] Furthermore, dual X-ray absorptiometry (DXA) is considered the gold standard of quantification for BMD.[4]

Several studies have investigated mandibular radiomorphomertic indices with panoramic radiography as predict factors for osteoporosis, such as mental foramen index (MI), mandibular cortical index (MCI) and panoramic mandibular index (PMI).[5] These indices should be useful for predict factors of decreased BMD.[6]

Cone-beam CT (CBCT) is a comparatively new modality by offering accurate anatomical information by three dimen-

*Correspondence: Ichiro Ogura; Email: ogura@ngt.ndu.ac.jp; Address: Department of Oral and Maxillofacial Radiology, The Nippon Dental University School of Life Dentistry at Niigata, 1-8 Hamaura-cho, Chuo-ku, Niigata, Niigata 951-8580, Japan.

sions at diagnosis and treatment planning.[7] Recently, 3D image datasets obtained from CBCT have been applied to investigating the potential osteoporosis prediction from the mandible, such as mandibular CBCT radiomorphomertic indices,[8–10] radiographic density,[11] and CT values.[12] However, it remains unclear whether age correlates with mandibular cortical bone radiographic density using CBCT. Here we report the result of investigation into the relationship between aging and mandibular cortical bone density with CBCT.

2. Materials and methods

Between April 2016 and September 2017, 202 patients (73 men and 129 women, mean 43.2 years, range 11-82 years) were examined in mandibular region with CBCT at our university hospital. The patients with medical history about bone pathology was excluded in this study. These patients were classified into 2 age categories: young group ($\leq$ 50 years); 51 men (mean 27.6 years, range 13-50 years) and 73 women (mean 30.0 years, range 11-50 years) and elderly group (> 50 years; 22 men (mean 63.8 years, range 53-74 years) and 56 women (mean 66.3 years, range 51-82 years). All patients offered written informed consent. Furthermore, the ethics committee of our institution approved this study.

The images were acquired with a CBCT using our protocol.[13, 14] We used regions of interest (ROI) to calculate the mandibular cortical bone radiographic density as gray values on the CBCT device. We placed three ROIs within the cortical bone of lower border of mental foramen to obtain a mean radiographic density (see Figure 1).

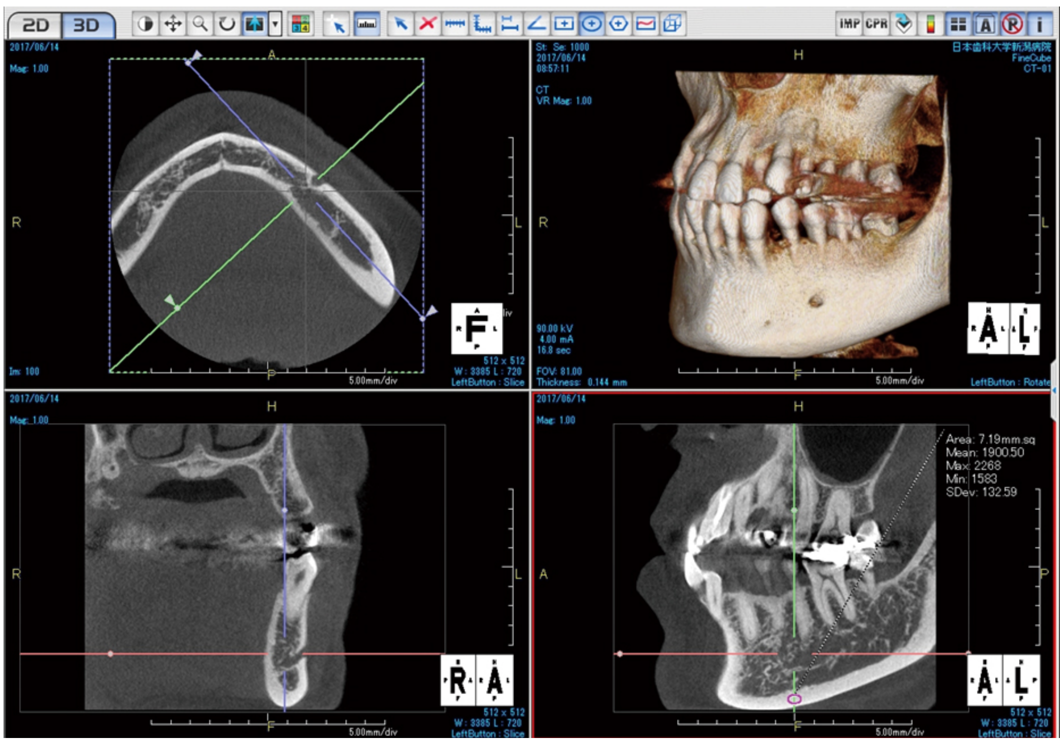

Figure 1. Measurement of the mandibular cortical bone radiographic density with CBCT

The relationship between aging and mandibular cortical bone radiographic density with CBCT was analyzed using Pearson's rank correlation test and the coefficient of determination (R^2). Regarding the age groups, mandibular cortical bone radiographic density with CBCT was analyzed using ANOVA with Tukey's HSD test. We analyzed using the IBM SPSS Statistics statistical package (version 24, IBM Japan, Tokyo, Japan). A p value less than .05 was considered to indicate statistically significant difference.

3. Results

Figures 2 and 3 show the relationship between aging and cortical bone radiographic density of mandible using CBCT. Cortical bone radiographic density in male using CBCT was not significantly correlated to age ($Y = -0.929X + 1584, R^2 = 0.013, p = .343$). On the other hand, cortical bone radiographic density in female using CBCT was significantly correlated to age ($Y = -6.741X + 1946, R^2 = 0.351, p = .000$).

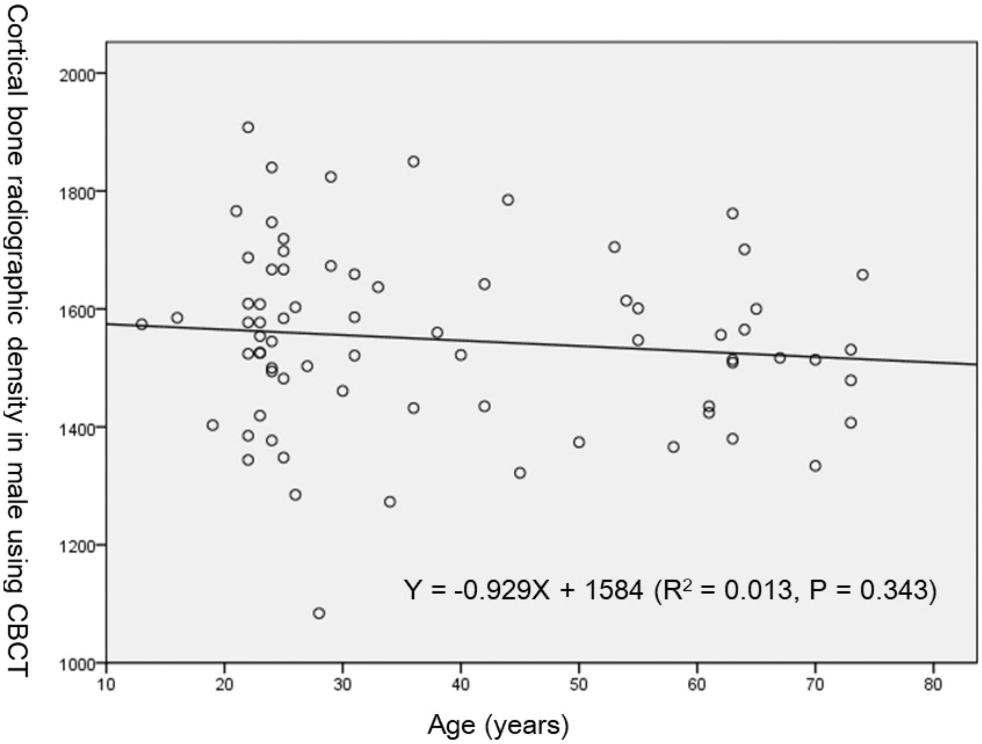

Figure 2. Scatter plot shows the relationship between aging and mandibular cortical bone radiographic density in male using CBCT

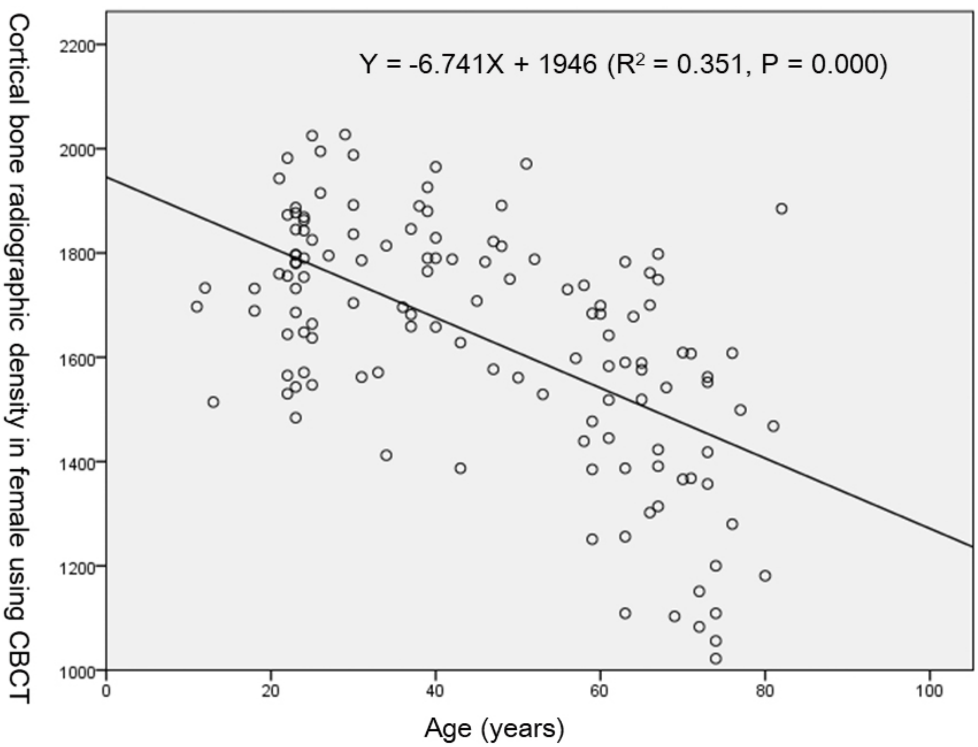

Figure 3. Scatter plot shows the relationship between aging and mandibular cortical bone radiographic density in female using CBCT

Table 1 shows the changes of mandibular cortical bone with age using CBCT. The cortical bone radiographic density in young female (1754 ± 144) was significantly higher than that in young male ($1554 \pm 164, p = .000$), elderly male ($1533 \pm 115, p = 0.000$) and elderly female ($1484 \pm 228, p = .000$).

Table 1. Changes of mandibular cortical bone radiographic density with age using cone-beam computed tomography

Age groups (Mean ± SD)	Cases	Mean ± SD	Range	*p*
Elderly female (66.3 ± 7.3 years)	56	1,484 ± 228	1,022～1,971	.000
Elderly male (63.8 ± 6.4 years)	22	1,533 ± 115	1,334～1,762	.000
Young male (27.6 ± 7.7 years)	51	1,554 ± 164	1,084～1,908	.000
Young female (30.0 ± 9.7 years)	73	1,754 ± 144	1,387～2,027	--

Note. SD, standard deviation

4. Discussion

The CBCT technique for dental use provides 2D and 3D images for the oral and maxillofacial regions with a comparatively low cost as compared to multidetector CT. The radiation dose is equal to that of panoramic radiography for the case of small FOV. For these reason, CBCT spread rapidly in dentistry.[11] In recent years, 3D image datasets obtained from CBCT have been applied to investigating the potential osteoporosis prediction.[8–12] Therefore, we investigated the changes of mandibular cortical bone with age using CBCT.

Regarding correlation CBCT with osteoporosis, Koh et al.[8] indicated that the differences between the normal and osteoporotic groups were significant in the CT mandibular index and CT cortical index. Mostafa et al.[9] showed that CT mental index, CT mandibular index and CT cortical index scores were significant differences between the control and osteoporotic groups. Brasileiro et al.[10] indicated that the mean values of CT index and CT mandibular index were lower in the osteoporosis group than in osteopenia and normal patients. Therefore, we consider that cortical bone density of mandible with CBCT should be utilized as predict factor of osteoporosis.

Barngkgei et al.[11] showed that lumbar vertebrae and femoral neck osteoporosis should be estimated with high accuracy from the radiographic density value of the mandibular body with CBCT. Güngör et al.[12] showed that Osteoporosis caused significant changes in radiomorphometric indexes, CT values, histogram analysis and fractal dimension measurements in the jaw bones. In this study, we have shown that the cortical bone radiographic density in female using CBCT was significantly correlated to age ($Y = -6.741X + 1,946, R^2 = 0.351, p = .000$). Furthermore, the cortical bone radiographic density in young female ($1,754 \pm 1,44$) was significantly higher than that in young male ($1,554 \pm 164, p = 0.000$), elderly male ($1,533 \pm 115, p = .000$) and elderly female ($1,484 \pm 228, p = .000$).

After approximately 30 years, decreasing bone mass happens with age, especially after menopause in female.[8] We confirmed the changes of mandibular cortical bone with age in female using CBCT, and consider that the evaluation of mandibular cortical bone using CBCT should be useful for predict factor of decreased bone mineral density.

This study has several limitations. First, CBCT gray values are regarded approximate values, and cannot be indicated as Hounsfield Unit (HU).[15] However, CBCT are becoming popular among the dentistry. It is now commonly utilized for the assessment of bone quality primarily for pre-operative implant planning. Therefore, we consider that evaluation of mandibular cortical bone by CBCT gray values can be useful in dentistry. Second, we did not evaluate the data regarding the medical history of the patients, such as osteoporosis. Therefore, future studies should focus on relationship between medical history and the changes of cortical bone of mandible are necessary.

5. Conclusions

We confirmed the changes of cortical bone of mandible with age in female using CBCT. Furthermore, the evaluation of mandibular cortical bone using CBCT should be useful for predict factor of decreased bone mineral density.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP 18K09754.

Conflicts of Interest Disclosure

The authors declare that they have no competing interests.

References

[1] Link TM. Osteoporosis imaging: state of the art and advanced imaging. Radiology. 2012; 263: 3-17. PMid:22438439. https://doi.org/10.1148/radiol.12110462

[2] Kazakia GJ, Majumdar S. New imaging technologies in the diagnosis of osteoporosis. Rev Endocr Metab Disord. 2006; 7: 67-74. PMid:17043763.

[3] Bauer JS, Link TM. Advances in osteoporosis imaging. Eur J Radiol.

2009; 71: 440-449. PMid:19651482. https://doi.org/10.1016/j.ejrad.2008.04.064

[4] Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. BMJ. 1996; 312: 1254-1259. PMid:8634613. https://doi.org/10.1136/bmj.312.7041.1254

[5] Taguchi A. Triage screening for osteoporosis in dental clinics using panoramic radiographs. Oral Dis. 2010; 16: 316-327. PMid:19671082. https://doi.org/10.1111/j.1601-0825.2009.01615.x

[6] Calciolari E, Donos N, Park JC, et al. Panoramic measures for oral bone mass in detecting osteoporosis: a systematic review and meta-analysis. J Dent Res. 2015; 94: 17S-27S.

[7] da Silva EJNL, Prado MC, Queiroz PM, et al. Assessing pulp stones by cone-beam computed tomography. Clin Oral Investig. 2017; 21: 2327-2333. PMid:27942985. https://doi.org/10.1007/s00784-016-2027-5

[8] Koh KJ, Kim KA. Utility of the computed tomography indices on cone beam computed tomography images in the diagnosis of osteoporosis in women. Imaging Sci Dent. 2011; 41: 101-106. PMid:22010066. https://doi.org/10.5624/isd.2011.41.3.101

[9] Mostafa RA, Arnout EA, Abo EI-Fotouh MM. Feasibility of cone beam computed tomography radiomorphometric analysis and fractal dimension in assessment of postmenopausal osteoporosis in correlation with dual X-ray absorptiometry. Dentomaxillofac Radiol. 2016; 45: 20160212. PMid:27418348. https://doi.org/10.1259/dmfr.20160212

[10] Brasileiro CB, Chalub LLFH, Abreu MHNG, et al. Use of cone beam computed tomography in identifying postmenopausal women with osteoporosis. Arch Osteoporos. 2017; 12: 26. PMid:28265896. https://doi.org/10.1007/s11657-017-0314-7

[11] Barngkgei I, AI Haffar I, Khattab R. Osteoporosis prediction from the mandible using cone-beam computed tomography. Imaging Sci Dent. 2014; 44: 263-271. PMid:25473633. https://doi.org/10.5624/isd.2014.44.4.263

[12] Güngör E, Yildirim D, Cevik R. Evaluation of osteoporosis in jaw bones using cone beam CT and dual-energy X-ray absorptiometry. J Oral Sci. 2016; 58: 185-194. PMid:27349539. https://doi.org/10.2334/josnusd.15-0609

[13] Sue M, Oda T, Sasaki Y, et al. Age-related changes in the pulp chamber of maxillary and mandibular molars on cone-beam computed tomography. Oral Radiol. 2018; 34: 219-223. PMid:30484030. https://doi.org/10.1007/s11282-017-0300-1

[14] Ogura I, Ono J, Okada Y. Use of cone-beam computed tomography for evaluation of surgical specimen of medication-related osteonecrosis of the jaw. J Oral Maxillofac Radiol. 2018; 6: 17-20. https://doi.org/10.4103/jomr.jomr_3_18

[15] Hua Y, Nackaerts O, Duyck J, et al. Bone quality assessment based on cone beam computed tomography imaging. Clin Oral Implants Res. 2009; 20: 767-771. PMid:19489931. https://doi.org/10.1111/j.1600-0501.2008.01677.x